ARKIV FÖR FYSIK Band 2 nr 22

Read 23 November 1949

Reports from the Conference of the Swedish National Committee for Physics in 1949

By Erik Hulthén and Erik Rudberg

The Swedish National Committee for Physics held its fourth general conference[1] in Stockholm on September 26–27, 1949. A representative number of physicists from all Swedish institutions engaged in research in experimental or theoretical physics, fundamental and applied, took part in the meeting. Several distinguished visiting scientists from other countries were also present. The lectures and discussions of the first day and the afternoon sessions of the second day were held in the new lecture rooms of the Royal Institute of Technology. Part of the afternoon of the first day was devoted to visiting the Institute's new laboratories for physics. The morning session on the second day met at the Institute for Radiophysics, where the various laboratories, including the new hall for high power high voltage x-ray work, were subsequently shown.

At the opening of the conference, professor A. Guinier, Paris, delivered a guest lecture entitled: "Imperfections of crystal lattices formed in solid state reactions." The lively interest among physicists commanded by this conference, as evidenced by the great number of contributed papers presented for discussion — some 50 in all — made it necessary to split up the meeting into sections, running in parallel. Short abstracts of the papers are published in this report, grouped in the same order in which they appeared on the conference programme.

K. Siegbahn and S. du Toit, Nobel Institute for Physics, Stockholm

Internal pair formation

At sufficiently high excitation energies (> 1.02 MeV) a nucleus can transfer its energy to a positron-electron pair, which is created internally in the field of the nucleus itself. This process has, so far, only been accurately studied experimentally for som naturally active, heavy isotopes. The theoretically calculated cross-section is quite small (conv. coeff. $\sim 10^{-3}$–10^{-4}), and is rather strongly dependent on energy but not very much on Z and multipole order. We have found the effect in Na^{24} and have determined the coefficient for it spectrometrically. Furthermore, we have found the internal conversion line of the 2.76 MeV γ-ray, which is a 100 times weaker than that of any hitherto investigated (Co^{60}). The conversion coefficient (3.10^{-6}) was determined and fits the calculated value for a quadrupole transition.

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[1] Secretary of the Conference: Dr. S. Benner, Institute for Radiophysics, Stockholm 60.

A. HEDGRAN, K. SIEGBAHN and S. DU TOIT, Nobel Institute for Physics, Stockholm

The photo cross-section for lead at the γ-energies 1.38 and 2.76 MeV

At present the most accurate method to determine the intensities of γ-rays is based on the measurement of the intensities of the corresponding photo-lines obtained from a thin converter of lead or any other element with high Z-value. If the intensities of the photo-lines are divided by the photo cross-sections at the energies in question one gets, under certain conditions, the relative intensities of the γ-rays themselves. It is therefore necessary to know accurately the photo cross-section as a function of energy. One can use either HEITLER's theoretical relationship or GRAY's empirical one. These two fit very well at energies below 1 MeV but above this begin to deviate from each other. Above this energy no careful experimental investigations have been made. In order to study this question more closely the photo-lines from the two γ-rays of Na^{26} at 1.38 and 2.76 MeV (known to be emitted in cascade thus giving the same intensity) have been investigated in the double focussing spectrometer using high resolving power. The profiles of the two lines were studied in considerable detail. The results thus obtained will be used in an investigation of the photo disintegration cross-section for deuterium at different γ-energies in collaboration with VON HALBAN's group in Oxford.

K. SIEGBAHN and S. THULIN, Nobel Institute for Physics, Stockholm

A spectrometric investigation of Kr^{88} and Rb^{88} obtained by fission and mass separation

J. KOCH and co-workers[1] have recently performed an isotope separation of the krypton fission gases and then made some absorption measurements on the different isotopes. The radiation is very complex and the conclusions which can be drawn from these measurements are, therefore, limited in scope. After some improvements in our previously described magnetic isotope separator,[2] we are now able to produce separated active isotopes in such quantities that spectrometric investigations of the separated products can be made. A new high transmission magnetic lens spectrometer[3] has been used in order to detect weak radiation and a number of different β-components have been measured. Two strong internal conversion lines of very low energy (corresponding to the K and L conversion lines of a γ-ray of 27 keV) were discovered in the spectrum of Kr^{88}. By means of $e\beta$ coincidences (i.e. between the focussed electron lines and the continuous spectrum) performed in the spectrometer with different absorbers in front of the β-counter registering the continuous spectrum, the emission of the strong 27 keV γ-line has been localized to occur after the soft (and strongest) β-component in this spectrum. The disintegration schemes of the two isotopes are subject to discussion.

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[1] J. KOCH, O. KOFOED-HANSEN, P. KRISTENSEN, and W. DROST-HANSEN, Phys. Rev. *76*, 279 (1949).

[2] I. BERGSTRÖM, S. THULIN, N. SVARTHOLM and K. SIEGBAHN, Ark. f. Fysik *1*, 281 (1949).

[3] H. SLÄTIS, and K. SIEGBAHN, Phys. Rev. *75*, 1955 (1949).

I. Bergström, Nobel Institute for Physics, Stockholm

Some investigations with electromagnetically separated isotopes

The electromagnetic isotope separator at the Nobel Institute for Physics has hitherto been used mainly in connection with the following types of nuclear physics investigations:

1. Mass number determinations of radioactive isotopes, *e.g.* Se^{81} (17 min.), Se^{81*} (58 min.), Xe^{137} (3.5 min.), Xe^{138} (17 min.), Cs^{138} (33 min.), Hg^{199*} (43 min.), Hg^{203} (51.5 d).
2. Production of carrier free samples of atoms having the same mass for β spectroscopy. (Determination of internal conversion-coefficients etc.) The method has also been used to produce β-samples of gases convenient for spectrometer investigations, *e.g.* the fission gases Kr and Xe.
3. Targets for a high voltage machine in collaboration with Tangen's group in Oslo.
   a) Proton resonances in the Mg isotopes.
   b) Investigation in order to find α particles of low energy in the reaction $\mathrm{Li}^7\ (\mathrm{p}\gamma)\ 2\,\alpha$.
   c) Investigation of the angular distribution of He^3 and He^4 in the reaction $\mathrm{Li}^6\ (\mathrm{p}\alpha)\ \mathrm{He}^3$.

G. Lindström, Nobel Institute for Physics, Stockholm

A precision method of measuring nuclear magnetic moments

An arrangement for the determination of nuclear magnetic moments with high precision is described which is of the same type as that described earlier by K. Siegbahn and G. Lindström in a paper entitled: "The nuclear magnetic moment of D^2, Li^7 and F^{19} studied by the magnetic resonance absorption method."[1]

The main difference is that the present arrangement consists of some crystal controlled channels with matched high-frequency bridges and preamplifiers. By using two different bridges and a double beam oscillograph it is possible to determine the ratio between two nuclear magnetic moments with high accuracy.

E. Kondaiah, Nobel Institute for Physics, Stockholm

Observations on the disintegration of ${}_{55}\mathrm{Cs}^{131}$

Barium was irradiated in the pile at Harwell, England. The active Ba thus obtained decays as follows:

$${}_{56}\mathrm{Ba}^{130} + {}_{0}\mathrm{n}^{1} \longrightarrow {}_{56}\mathrm{Ba}^{131} + \gamma \xrightarrow[\text{(K-cap.)}]{} {}_{55}\mathrm{Cs}^{131} \xrightarrow[\text{(K-cap.)}]{} {}_{54}\mathrm{Xe}^{131}$$

The Cs that grows from Ba was separated and purified chemically and found to have a half-life of 9.7 ± 0.3 days. It is being studied in a magnetic lens spectrometer. The Cs sample emits X-rays as well as γ-rays. The Auger electron spectrum has been investigated, and a number of conversion lines have been found.

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[1] Ark. f. Fysik *1*, 193 (1949).

Guy von Dardel, Research Institute of National Defence, Stockholm

A preliminary measurement of the half-life of RaC′

A 20-channel electronic time analyzer has been used to determine the half-life of RaC′. The source was a small radon needle (glass wall thickness about 7.5 mg/cm^2), placed inside a thin-walled proportional counter. The apparatus registered simultaneously the number of α-ray pulses from this proportional counter falling in 20 time intervals succeeding a β-ray, registered in six thin-walled G. M. counters surrounding the proportional counter. The time scale was determined by a 1 Mc crystal oscillator. A special electronic circuit made the widths of the channels identical and independent of tube characteristics etc. The width chosen was 80 or 100 μsec. Under these conditions of measurement all major sources of systematic error should be eliminated, and the accuracy limited by the statistical fluctuations of the number of counts alone. Preliminary measurements indicate a half-life of 160 μsec. The mean square error, calculated according to Peierls,[1] is ± 1 μsec, but the measurements will have to be checked before this accuracy can be claimed with certainty. The preliminary result is in fair agreement with the previous value of Jacobsen and Sigurgeirsson[2] ($155 + 5$ μsec).

L. Minnhagen, Department of Physics, University of Lund

Cloud-chamber investigation of ^{235}U fission fragment ranges in air

The mean ranges in air of the ^{235}U fission fragments were measured by means of a 25 cm cloud-chamber and were found to be 19.5 mm for the short range group, and 25.4 mm for the long range, a total range of 44.9 mm at S. T. P. These values should correspond to the most probable fission masses 139 and 94. It is noteworthy, that the mean ranges for the masses 139 and 94 in the ^{239}U fission are 19.3 and 25.1 mm, respectively, as given by Katcoff, Miskel and Stanley.[3]

The mean total range fo the ^{235}U fission fragments in Ilford nuclear research emulsions B1 and C2 is about 1830 times smaller than in air at S. T. P., the corresponding figure for UII alpha-particles being 1680. The average relative stopping power of the emulsion for fission fragments over this range is thus about 8 percent larger than for UII alpha-particles. This l due to the large content of silver, bromine and hydrogen in the emulsion.

The investigation was carried out at the Institute for Theoretical Physics, Copenhagen, together with J. K. Böggild and O. B. Nielsen.

S. Johansson and K. Siegbahn, Nobel Institute for Physics, Stockholm

A pair spectrometer of lens type

In transmutation experiments by means of high voltage machines, highly excited compound nuclei are formed, which very often emit hard γ-radiation, sometimes of the order of 10 MeV. If this radiation is examined one has the opportunity to determine the excited states of the nuclei. At these high energies, pair formation is the dominating process and the photo effect is small. There have been some earlier attempts to use the pair formation effect for energy measurements of the γ-radiation. Since the negatron and positron are emitted simultaneously, the background can be considerably reduced by using G.M.-tubes in coincidence, one of them registering the negatron and the other the positron.

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[1] Proc. Roy. Soc. *A 149*, 467 (1935).
[2] Det Kgl. Danske Vid. Selsk. *20*, No. 11 (1943).
[3] Phys. Rev. *74*, 631 (1948).

In a homogeneous transverse magnetic field the two electrons are bent away in opposite directions. "Coincidence-lines" will be found when the applied magnetic field corresponds to the focussing of the electron energy $^1/_2\,(\mathrm{E}\gamma - E_0)$, where $\mathrm{E}\gamma =$ the energy of the γ-ray and $E_0 = 1.02$ MeV.

The purpose of the present investigation is to try to make use of a magnetic lens, with its great inherent transmission, to register the electron pairs. Since an ordinary lens cannot separate negatrons and positrons and still be able to register them simultaneously, the following arrangement has been made. The electron pair converter is placed 1.5 cm from the optical axis of the lens. Because of the fact that the rotation of image for a short lens is $\neq 360°$ and that positive and negative electron paths are twisted in opposite directions along the axis, one can obtain two well-defined and separated images of the converter after the electrons have passed through the lens, one of the images being due to negatrons and the other to positrons. This was investigated photographically, after which two G.M.-tubes were placed with their slits coinciding with the two images. The tubes were coupled in coincidence.

The new pair spectrometer has been tested on the γ-radiation from ThC″ and Na^{24} and good coincidence lines have been obtained. The γ-energies calculated from these measurements are very similar to those one would expect. At higher γ-energies conditions ought to be still more favourable, especially in view of the smaller angle between the emitted negatron and positron.

STIG BRIMBERG, Department of Physics, Royal Institute of Technology, Stockholm

An experimental investigation of the multiple scattering of electrons from P^{32}

Measurements of multiple scattering of the β-rays of P^{32} have been carried out. A carefully canalized β-radiation was used. The canalized β-particles were passed through a thickness x of Al-foil, which was varied from 22 μ to 1250 μ. The angular distribution of the elctrons $n(\Theta)$ after the passage through the Al-foils was measured. The maximum value of the expression $\sin\Theta \cdot n(\Theta)$ gives the angle λ, which is the most probable one. The relation found between λ and $\sqrt{\frac{x}{\cos\lambda}}$ is linear, in agreement with the theory for homogeneous β-rays. That this relation holds, in spite of the continuous energy distribution of the β-rays used, makes it probable that the average energy of the β-rays changes only slightly when the β-rays pass through the scattering foil. This point was tested in the following way: The average energy of the electrons for foil thicknesses of 22 to 322 μ Al was calculated according to GOUDSMIT and SAUNDERSON[1, 2]. This value of the average energy was compared with the value derived from the β-ray spectrum of P^{32}, the thickness of the counter wall

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[1] S. GOUDSMIT and F. L. SAUNDERSON, Phys. Rev. *57*, 24 (1940).

[2] S. GOUDSMIT and F. L. SAUNDERSON, Phys. Rev. *58*, 36 (1940).

being taken into account. For the thinnest scattering-foils used a difference of about 10 % was found, when the average energies obtained by both methods were compared.

O. KOFOED-HANSEN, Institute of Theoretical Physics, University of Copenhagen, Denmark

On γ-ray intensity measurements by Gray's method

In GRAY's method[1] the source is placed in the centre of a large absorber, and the intensity (i.e. the γ-energy per disintegration × the number of disintegrations) is determined by the integral

$$J = 4\pi \varrho W \int_0^\infty J(r)\, r^2 \,\mathrm{d}r \tag{1}$$

where $J(r)$ is the number of ion pairs created per cc. per sec. in a small ionisation chamber introduced into the absorber in a distance r from the source, ϱ is the ratio of stopping powers for electrons of the absorber and the gas in the chamber, and W is the energy expenditure per ion pair.

The most important sources of error in the determination of the integral in (1) may be summarized as follows: (I) The definition of r. (II) The correction for the finite dimensions of the ionisation chamber. (III) The measurement of r. (IV) The extrapolation of the intensity of ionisation to small distances r. (V) The influence of the finite size of the source.

These five sources of error introduce an uncertainty in the measurement which is quite large (≈ 30 % for γ-ray energies of ≈ 0.1 MeV). However, these errors may be reduced by some slight changes in procedure. If it is assumed that the radioactive material being used is distributed at a density of n millicurie per cc in an infinite absorber and a small spherical ionisation chamber of radius R is introduced into the absorber, then the number of ion pairs, N, per cc per sec. created in the chamber is given by

$$\varrho W N = n E \tag{2}$$

where E is the γ-ray energy emitted per millicurie per sec. It is also possible to determine N from the absorption curve found in GRAY's experiment, *i.e.* from the integral

$$N = 4\pi n \int_R^\infty J(r) \cdot r^2 \,\mathrm{d}r \tag{3}$$

where now $J(r)$ is the number of ion pairs created per cc. per sec. in the chamber by a millicurie sample in the distance r, when r is *defined* as the distance from the source to the center of the chamber. It follows from (2) and (3) that the correction for the finite size of the chamber is given by

$$J'(r) \cdot r^2 = J(r)\, r^2 + R \cdot \frac{\mathrm{d}\,(J(r) \cdot r^2)}{\mathrm{d}r} \tag{4}$$

where $J'(r)$ means the corrected J value.

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[1] L. H. GRAY, Proc. Roy. Soc. *A 122*, 648 (1928), *A 156*, 518 (1936) and *A 159*, 263 (1937).

The sources of error from III–V may be overcome to some extent by using a lighter material as the absorber (*e.g.* water instead of aluminium), by using spherically symmetric sources, and by modifying the apparatus so that the source is placed in the centre of a relatively large empty sphere inside the absorber. In this way, GRAY's intensity integral may easily be determined with an accuracy of $\approx 1\%$ for γ-ray energies down to 0.1 MeV.

KRISTER KRISTIANSSON, Department of Physics, University of Lund

A search for τ-mesons

Some years ago an investigation of cosmic rays was started using nuclear research emulsions which were exposed in the upper part of the atmosphere. A great many tracks have been found on the plates, and the masses of the particles which made the tracks have been measured. The determination of the masses can be done by two methods, the grain-counting method, and the small-angle-scattering method. When the masses were determined by the grain-counting method, a very small number of particles with masses of about 1000 electron masses were found. It might possibly be assumed that these particles were τ-mesons.

However, in order to obtain a verification of this assumption, new determinations of the masses of these particles were made by the small-angle-scattering method and gave the result that it was protons and deuterons and not τ-mesons that had been found.

KARL-ERIK LARSSON, Research Institute of National Defence, Stockholm

Determination of the diffusion length of thermal neutrons in water using a small boron chamber

With a small BF_3-chamber as detector the diffusion length (L) of thermal neutrons in water has been determined. 100 and 250 mC of Ra mixed with beryllium were used as neutron sources. As a simple theoretical relation between neutron density (ϱ) and diffusion length (L) is predicted by diffusion theory only in the case of a source-free region, a series of differential measurements was made. The neutron density was studied for the case of spherical symmetry with and without a cadmium absorber. The difference of these measurements represents a density (ϱ) of thermal neutrons which, according to diffusion theory, is a function $\varrho(r)$ of the distance r from the source:

$$\varrho(r) = C \cdot \frac{e^{-\frac{r}{L}}}{r}$$

By use of this relation L has been determined as a function of the quantity of the absorbing medium. Two important disturbances in the distribution of neutron density, caused by shadowing effects and changed source distribution in measurements of this kind, were investigated and corrected for, and the value of L for thermal neutrons was determined to be $L = 3.25 \pm 0.13$ cm.

A detailed description of the experiment will be published in the near future.

BENGT EDLÉN, Department of Physics, University of Lund

Extrapolation formulae for isoelectronic sequences in atomic spectra

From SOMMERFELD's general formula for x-ray levels follow directly as special cases "Mosely's law", the "irregular doublet law", and the "regular doublet law." These well-known relations have been extremely useful in the study of both x-ray spectra and the spectra of isoelectronic sequences of stripped atoms. For many purposes, however, it would be very desirable to possess more accurate extrapolation formulae. Several such semi-empirical formulae are demonstrated, reproducing within the errors of observation all the observed values of selected isoelectronic sequences with a minimum number of adjustable parameters.

ALBIN LAGERQVIST, Department of Physics, University of Stockholm

The course of perturbations in molecular spectra

A simple method to discover perturbations in band-spectra of diatomic molecules is to plot the expression $\frac{1}{4J}[R(J-2)-R(J-1)+P(J)-P(J-1)] = B''-B'-6D''+2(D'-D'')J^2$ against J. For unperturbed bands an almost horizontal line is obtained, giving $B''-B'$ at $J=0$, the effect of the constants D being generally very small. For perturbed levels the points are displaced from the horizontal to such an extent that two curves must be obtained, the point of intersection having the ordinate $\frac{B'+B_{\text{pert}}}{2}-B''$. From this expression we can determine the B-value B_{pert} of the perturbing state. In BaO, B_{pert} has been determined with four figure accuracy.[1] The method also makes it possible to calculate the vibrational frequencies of the perturbing state.

K. LIDÉN, Department of Physics, University of Lund

Photoelectric measurements of the intensities of the Rowland ghosts used as reference points for a linear intensity scale

As part of a study of the arc spectrum of fluorine an attempt was made to use a linear intensity scale for the spectral lines investigated in the region 3 000–12 000 Å with a 6.5 m concave grating spectrograph in a Wadsworth mounting. The intensities of the Rowland ghosts 1, 2, 3, 4, and 5 of certain lines of Hg I and Na I were measured in relation to the parent line, using a good 1P21 photomultiplier tube connected to a continuously variable voltage supply, carefully stabilized. Then the ghosts of the strongest F I lines were used as reference points on the linear scale. Using the spectral sensitivity curves of the spectroscopic emulsions from Eastman Kodak Co. this scale was extended to the whole wave-length range 3 000–12 000 Å. The reliability of the method was studied on lines from long Rydberg series in F I.

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[1] A. LAGERQVIST, E. LIND and R. BARROW, The band Spectrum of barium oxide. (in the press)

SVEN GLAD, Department of Physics, University of Lund

A light source for the spectrum of doubly ionized iron

Various modifications of the hollow cathode discharge have been tried in order to find a light source which produces the spectrum of Fe III with sufficient intensity and which, at the same time, permits an experimental separation of Fe III from neighbouring ionization stages.

It has been proved that a condensed hollow cathode discharge will satisfy these demands. The hollow cathode is placed in a glass bulb of 180 mm diameter. It consists of a graphite tube fitted with an inner thin-walled iron cylinder, 7 mm diameter, 50 mm length. A full-wave rectifier charges a 12 μF condenser, which is connected to the discharge tube through a rotating spark gap. At a suitable helium pressure, about 7 mm Hg, an oscillatory discharge takes place inside the hollow cathode. A luminous layer appears along the walls of the cathode, while the inner space of the cylinder is traversed by a very large number of small sparks. It appears that these sparks give almost exclusively the spectrum of doubly ionized iron, while the neutral and singly ionized iron is confined to the luminous layer along the walls. If the light source is focused end-on on the slit of a large glass-prism spectrograph, the intensity distribution along a diameter of the cathode tube is reproduced in each spectral line. Thus, the Fe III lines have nearly the same intensity from end to end while the Fe I and Fe II lines are much stronger at their ends and often disappear in the central part.

BENGT KLEMAN, Department of Physics, University of Stockholm

The use of multiplier cells to record hydride spectra in a hollow cathode discharge

The recording apparatus with an electron multiplier for spectroscopic investigations, of which a preliminary report was given at the conference in 1948, has recently been used in this laboratory for intensity measurements in hydride spectra.

Investigations show that the hollow cathode discharge is very stable and therefore suitable as a light source for direct recording. Generally speaking, the sensitivity in this range (4000–5000 Å) by direct recording is not less than by the photographic method. In the direct recording method if it is possible, as in our investigations, to work with rather broad slits, the sensitivity is increased considerably at the expense of the resolution, which is not the case in the photographic method. These investigations of the sensitivity have been carried out on AlH in a water-cooled SCHÜLER-GOLLNOW hollow cathode, and at the same time intensity studies of the breaking-off of the (00) band at 4240 Å have been made.

Preliminary investigations of the intensity course of the CuH-bands in a hollow cathode have been made and are to be continued using a hollow cathode cooled by liquid air.

ÅKE NILSSON, Department of Physics, University of Uppsala

A precision determination of the excitation potential of x-ray lines

A spectrometer with curved crystal and Geiger-Müller counter is used to determine the intensity of an x-ray emission line as a function of the voltage on the x-ray tube in the neighbourhood of the excitation potential of the line.

The intensity measurements are performed with one volt intervals, and the graphs recorded show edges that are dependent on the cathode type, and provided with a fine structure.

The difficulties of the investigation are connected with the necessity to suppress completely the formation of a carbon layer in the focal spot. Consistent results were obtained with efficient liquid air traps, a high temperature anticathode and an oscillating electron beam.

J. NYSTRÖM, Department of Physics, Royal Institute of Technology, Stockholm

Calorimetric investigations on order-disorder transitions in Au Cu

The order-disorder transition in Au Cu has previously been studied by means of x-rays and by resistivity measurements. Above 507° C there is a disorderly distribution of the atoms, and the lattice is cubic. Below this temperature there is order, and the lattice is tetragonal. BORELIUS has calculated the evolution of heat during the transition, and calorimetric measurements have been made between 330 and 400° C by means of two methods worked out in this laboratory. At low temperatures both theory and experiment give the same values for the evolution of heat, but in the range just below the transition point, the heat evolved is lower than that calculated. The heat per mol evolved in a thin wire is larger than that in a block of the alloy. It is possible that this difference is due to internal stresses in the specimens. New experiments are in progress to determine if this is correct.

PER-OLOV LÖWDIN, Department of Mechanics and Mathematical Physics,
University of Uppsala

The band theory of metals and the importance of the overlap integrals

In his fundamental work[1] on the electronic structure of metals, BLOCH constructed the crystal wave functions in the case of tight binding by means of linear combinations of atomic orbitals Φ_μ (LCAO). In this calculation he assumed that the overlap integrals

$$S_{\mu\nu} = \int \Phi_\mu^* \Phi_\nu \, d\tau$$

for orbitals Φ_μ and Φ_ν associated with different atoms could be neglected, approximately. However, later computations with this model (BETHE-SOMMERFELD and others) showed that this picture was too crude and, therefore, it has not been employed in practical applications. Other methods for constructing the crystal functions have instead been worked out, *e.g.* the cellular method.

In the literature concerning molecules and crystals — with the exception of the case of H_2 and similar molecules — it has been almost universally assumed that it was justifiable to neglect the overlap integrals. However, in an investigation of ionic crystals[2] — which may be considered as a continuation of HYLLERAAS's work[3] on LiH and LANDSHOFF's work[1] on NaCl — the author has found that the overlap integrals, instead of being negligible, are of fundamental importance for the theory, since they alone correspond to the repulsive forces in the crystal. If these integrals are neglected, as is usually done, the whole approximation breaks down. Consequently, it seems natural to consider that a similar neglect in BLOCH's treatment of tight binding could be responsible for the rather unsatisfactory results earlier obtained.

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[1] F. BLOCH, Z. Phys. *52*, 555 (1928).

[2] P. O. LÖWDIN, Ark. f. mat., astr. o. fysik *35 A*, nos. 9 and 30 (1947). — A Theoretical Investigation into Some Properties of Ionic Crystals, Thesis, Uppsala 1948.

[3] E. A. HYLLERAAS, Z. Phys. *63*, 771 (1930).

By means of the orthonormalized atomic orbitals, introduced by the author in the theory of ionic crystals[2], new Bloch functions have been constructed, where the overlap integrals have been taken into complete account. By using antisymmetric combinations of these crystal functions, it is possible to reconsider the problems of band structure, cohesive energy, elastic constants, and magnetic properties etc. The numerical computations now in progress can partly be carried out according to the same scheme that has earlier been used for ionic crystals.

The corresponding problem in the molecular orbital theory of quantum chemistry has been treated too. It may be pointed out that the overlapping adds interesting new features to the properties of molecules and crystals, *e.g.* the "many-orbital-effects", corresponding to the many-body-forces in ionic solids.

A more complete report,[3] "On the Non-orthogonality Problem Connected with the Use of Atomic Wave Functions in the Theory of Molecules and Crystals", will be published in the Journal of Chemical Physics.

H. ALFVÉN, Department of Electronics, Royal Institute of Technology, Stockholm

On the origin of the terrestrial and solar general magnetic field

Many different theories have been proposed in order to explain the origin of the terrestrial and solar general magnetic field. There is good evidence in favour of the assumption that they are due to internal electric currents. The problem is to devise a self-exciting electric generator, which can be constructed out of such elements that may exist in the interiors of the earth and the sun.

A homopolar inductor surrounded by a system of rotating cylinders acts as a self-exciting generator and produces a magnetic field which, outside the generator, is approximately of dipole type. A system of whirls in the interior of the earth or the sun may give the same effect. A simple calculation shows that even very slow internal motions are enough to produce a field of the observed order of magnitude.

S. LUNDQUIST, Department of Electronics, Royal Institute of Technology, Stockholm

Experimental demonstration of magneto-hydrodynamic waves

The importance of magneto-hydrodynamic phenomena to different parts of cosmic physics becomes more and more evident. This fact and the mathematical difficulties of exact treatment of many problems make it necessary to consider the possibilities of experimental investigation. The solution of the equations for cylindrically limited waves shows that "ideal" waves in a liquid with finite conductivity can exist only in a certain frequency interval, the position of which depends upon the electrical conductivity, the outer magnetic field and the geometrical dimensions. Different media for the waves are compared, the most promising one being liquid sodium. An account is given of an experiment which demonstrates the existence of magnetohydrodynamic waves in mercury.

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[1] R. LANDSHOFF, Z. Phys. *102*, 201 (1936).

[2] See footnote 2 on the preceding page.

[3] P. O. LÖWDIN, Journ. Chem. Phys. *18*, 365 (1950).

K. G. MALMFORS, Department of Electronics, Royal Institute of Technology, Stockholm

On the variation of cosmic radiation

The results obtained from two years' recordings of the variations in cosmic ray intensity are i summarized. It is shown that the phase and amplitude of the diurnal variation depends on the direction of incidence. By analysing the daily variations it has been shown that quiet and disturbed periods exist. In order to describe this fact the term "cosmic ray activity" has been introduced.

C. H. JOHANSSON, Detonics Laboratory, The Nitroglycerine Co., Stockholm

The influence of velocity in adiabatic compression[1]

If a piston is moved with constant velocity (v) in an open cylinder, a layer of compressed air, the front of which is approximately discontinuous, gathers before the piston. The ordinary adiabatic formula (static adiabatic) is not valid for the rapid adiabatic compression of the front. Instead it is necessary to use the so-called RANKIN-HUGONIOT adiabatic formula (dynamic adiabatic) which can be written

$$p_2 \cdot \varrho_2^{-\varkappa} = B \cdot p_1 \cdot \varrho_1^{-\varkappa}$$

This equation gives the static adiabatic ($B = 1$) when $v \to 0$, in which case $p_2/p_1 \to 1$.

Piston speeds used technically, for instance in combustion engines, correspond to values of B which are appreciably greater than one. Nevertheless, the error introduced by using the static adiabatic is very small. This is due to the fact that the compression does not proceed in one step to the final pressure as in the front of a shock wave. The ratio p_2/p_1 is a single-valued function of v and at the piston velocities in question is only slightly above one. Therefore, the discontinuous front moves repeatedly backwards and forwards in the cylinder until the final pressure is attained, the pressure gradually rising the whole time.

H. VON UBISCH, Department of Chemistry, Karolinska Institutet, Stockholm

On the heat conductivity of rarefied gases

M. KNUDSEN's[2] formula for the conductivity of rarefied gases fails as soon as the pressure is increased sufficiently to decrease the mean free path of the molecules to a magnitude which is comparable with the diameter of the wire of the hot wire manometer. However, a formula recently deduced by S. WEBER[1] is found to agree with observations. A tungsten wire of diameter 0.01 mm at a temperature of 85° C above room temperature was used. The gases investigated were: H_2, He, CH_4, N_2, O_2, C_2H_6, A and CO_2. The pressure was gradually increased from 0.1 to 2 mm of mercury. A constant k in the formula increased from 2.0 at "zero" pressure (as suggested by WEBER) to an average of approximately 2.8 at 2 mm of mercury. In the case of hydrogen the "zero" value of k is probably only 1.6, whereas for argon it is 2.3.

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[1] C. H. JOHANSSON, "The influence of velocity in adiabatic compression." Arkiv f. mat., astr. o. fysik, *35 A*, No. 37 (1949).

[2] M. KNUDSEN. Ann. d. Phys. *34*, 593 (1911).

One of the consequences of KNUDSEN's formula for mixtures of gases is that conductivities can be obtained by linear interpolation between the conductivities of the component gases taken at identical pressures. Measurements on the mixtures H_2–He, H_2–N_2, N_2–CO_2, N_2–O_2 and N_2–A reveal that this is true within 0.5 %, even up to pressures of 2 mm of mercury. On the other hand, the conductivity of H_2–CO_2 and of H_2–C_2H_6 is, respectively, 2.6 and 8.5 % higher, and that of H_2–A is 1 % lower than is to be expected from this interpolation. These figures refer to 2.0 mm of mercury and to 1: 1 mixtures.

A detailed treatment will appear in the future.

H. SLÄTIS and K. SIEGBAHN, Nobel Institute for Physics, Stockholm

New type of focussing in a magnetic lens spectrometer

The focussing properties of an axially symmetric lens field with a minimum of the magnetic field in the middle of the lens has been studied. The magnetic field gradient was used as a variable parameter. A new type of high intensity focussing was then found and investigated rather in detail by means of a photographic tracing method. It was shown that for a certain distribution of the field (*i.e.* when the field in the middle of the lens is about five times smaller than that at the sample and at the detector), a first, ringshaped focussing takes place in the middle of the lens with a sharply defined outer diameter. The different rays cross each other here, and are then focussed to essentially one point on the axis at the detector. The new spectrometer has a maximum geometrical transmission, which is estimated to be about 8 % at a resolving power of 4 %. An ordinary type of G.M. counter of small dimensions can be used as distinct from previous ring-focus spectrometers adjusted for high transmission. The spectrometer is convenient to use for measurements of internal conversion coefficients etc. by means of $\beta\gamma$-coincidence spectrometry, because of the increased transmission.

O. KOFOED-HANSEN, J. LINDHARD and O. B. NIELSEN, Institute for Theoretical Physics, University of Copenhagen, Denmark

A new type of β-ray spectrograph

It is a common feature of the magntic β-spectrographs constructed hitherto that focussing is obtained only in a first approximation. However, from a theoretical point of view, it is possible to obtain exact focussing for nearly all rays emerging from the source, by a cylindrically symmetrical arrangement in which the line connecting source and focus is the axis of symmetry. The focussing field is perpendicular to the axis of symmetry, and to the radius from this axis to the point considered, and has the value $H_f = \text{const}/r$ inside a ringshaped volume, and $H = 0$ outside this volume. The boundary curve for this volume (the curve found by cutting the surface of the ring-shaped volume by a plane containing he axis of symmetry) has to be constructed so as to give exact focussing for any β-ray from the source.

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[1] S. WEBER, Kgl. Danske Vid. Selskab, Mat.-fys. Medd. *19*, 11 (1942) — see eq. 18.

An experimental approach to this theoretical possibility is realized by dividing the ring-shaped volume into wedge-shaped sections of roughly the same shape as the slices of an orange. Every second wedge-shaped section is filled with iron and copper coils and the other sections form a series of spectrographs utilizing the same source and focus.

A preliminary experiment with a single wedge-shaped gap covering a section of 18° of the whole ring-shaped volume (*i.e.* 1/20 of this volume) has given an effective solid angle of $\Omega \approx 0.03 \cdot 4\pi$ and a resolving power $1/R \approx 0.04$. It is thus seen that there is a possibility of increasing the total solid angle utilized in a final construction of the apparatus. It may be mentioned also that the dispersion compares favourably with other types of β-spectrographs.

A more detailed description of the theory of the apparatus and of the preliminary experimental investigations will be published elsewhere.

NILS RYDE and LARS KARSBERG, Department of Physics, Chalmers Institute of Technology, Gothenburg

Some notes on the construction of a 4 MV van de Graaff-generator at the Department of Physics, Chalmers University of Technology, Gothenburg

The big van de Graaff-generator, which is at present under construction, is an upright pressure-insulated model provided with 2 belts of about 1 meter's width. The high voltage terminal, which is supported by 4 columns of porcelain, is surrounded by an equipotential shield. 74 corona-rings with diameters increasing from about 1 m at the high voltage terminal to about 2 m at the ground side provide a homogeneous potential drop. Resistances of about 600 megohms are connected between consecutive rings. The current through these resistances amounts to about 0.1 mA at full voltage, while the generator is expected to give about 1 mA total current. It is intended to stabilize the voltage by impulses from a generating voltmeter, which will be added to the spray voltage. Fine stabilization for quicker variations will be obtained by an electron ray, which is passed through the acceleration tube from the base. The impuses for this stabilization are taken from the ion beam, which is curved in a magnetic and electric field. The acceleration tube, with an inner diameter of 30 cm, is evacuated at the base by a 3-step diffusion pump with a pumping rate of 900 lit./sec., backed by a forepump. The space between the ion source and the acceleration tube is evacuated by a diffusion pump of 250 lit./sec., placed within the high voltage terminal. The acceleration tube as well as the insulating columns are built of porcelain rings, which are put together with vinylseal.

T. GRAF, Laboratory of L. Meitner, Royal Institute of Technology, Stockholm

Construction of a multiple γ-counter of high efficiency and short resolving time

By combining three different methods of increasing the efficiency of a G.M. counter for γ-rays, a new detector was constructed which has the following advantages over a conventional G.M. counter made of brass:

1. A 6 to 20 times higher efficiency for equal size in the range 0.3 to 2.6 MeV.
2. A resolving time of a few microseconds only, in practice limited mainly by the resolving time of the amplifier.
3. A solid angle of nearly 4π for samples placed at the center of the multiple counter.
4. The distance function of the multiple counter follows closely the inverse-square law even for the shortest source-to-counter distances.

A more detailed paper on the construction and performance of the multiple counter has been submitted to the Review of Scientific Instruments for publication.

Bo Aler, Department of Physics, University of Stockholm

The efficiency of a scintillation-counter for γ-rays

The general properties of a scintillation-counter for γ-rays, consisting of a RCA 1P21 photo-multiplier and an organic scintillator, were described and a comparison was made with the Geiger-Müller-counter.

Different methods to eliminate the dark-current were discussed. When using the coincidence method it is necessary to amplify the pulses before the mixing stage to avoid a great loss in efficiency. It is troublesome to reduce the dark-current by cooling the tube with dry ice or liquid air, and, at the same time the risk of cracking the scintillator is great.

If one wishes to use a single multiplier at room temperature it is necessary to keep the dark-current constant. The main cause of fluctuations is the variation in temperature. This can be avoided by placing the potential-dividing resistances at a sufficient distance from the tube or, still better, by water-cooling.

With a reasonable background of 200 pulses per minute it is possible to count 50–60 per cent of the Compton-electrons from Co^{60} γ-rays with a 2 cm thick clear naphthalene crystal. Using anthracene under the same conditions one can count about 90 per cent of the Compton-electrons.

Sven A. E. Johansson, Department of Physics, University of Lund

Some applications of scintillation counters

At the Department of Physics in Lund scintillation counters have been studied and some different types of these counters have been constructed. The great advantage of these instruments is the great counting speed, which makes it possible to use them for the determination of very intense radiation. A counter has been built, which counts 10^7 particles per second. In this construction the background has been eliminated by coincidence coupling of two photomultipliers.

The size of the impulses obtained from a scintillation counter has been studied. One can prove that the size of the impulses depends on the energy of the particles that penetrate into the crystal, and that this dependence can be used for determining the energy. Attempts have been made to measure the energy of α- and γ-radiation from various sources in this way.

Preliminary experiments have been made in order to find out the applicability of the scintillation counter in investigations of cosmic radiation.

O. Wernholm, Department of Electronics, Royal Institute of Technology, Stockholm

A 35 MeV synchrotron

A short description of the function of the synchrotron and construction details of the magnet, accelerator tube and the r-f system is given.

Nils Svartholm, Nobel Institute for Physics, Stockholm

An electric doublet method in mass spectroscopy

In order to make use of the intrinsic high resolving power of a double focussing mass spectrometer with crossed magnetic and electrostatic fields of calculated distribution, one needs a substitute for the photographic doublet method. This can be achieved in the following way. The condition for dynamic balance of an ion of mass m describing a circle of radius r in the fields E and H

$$m v^2/r = e v H - e E \tag{1}$$

may be fulfilled for a single value of the velocity v (velocity focussing). For an ion of smaller mass, $m - \Delta m$, moving in the same fields, eq. (1) has two distinct solutions $v \pm \Delta v$ where $\Delta v/v \approx \sqrt{\Delta m/m}$ or $\Delta V/V \approx 2\sqrt{\Delta m/m}$, so that a determination of the relative mass difference entails simply the measurement of the *ratio* between two voltages (V) in the ion accelerating system. It is important to note that the result is independent of a knowledge of the precise values of E and H and that the "electric dispersion" follows a square law. The two solutions of eq. (1) have been demonstrated in an experimental mass spectrometer of rather small resolving power (≈ 600).

E. Åström, Department of Electronics, Royal Institute of Technology, Stockholm

Noise from electrons in a magnetic field

In a trochotron electrons move in trochoidal paths in crossed electric and magnetic fields. When the electrons have travelled a certain distance they are collected by an anode.

Measurements have shown that, when the current density in the electron beam is small, the noise has a shot noise character. When the density exceeds a certain value, the noise increases nearly exponentially with the current density. Noise energies up to 10^6 times the shot noise level have been found. The current at which the transition between these two regions occurs depends on the electric and magnetic field strengths and also on the dimensions. It is noteworthy that this current is approximately inversely proportional to the tube length (*i.e.* length of the electron path).

The measured noise spectrum has a maximum, in a certain experiment, at approximately 10 Mc/s, with slowly decreasing intensity towards lower and higher frequencies. Also, the noise voltages induced in two probes at different points (arbitrarily chosen near the space charge region) are correlated in such a way as to suggest that bunching of the electrons occurred, and that electron clouds of increasing size were developed in the electron gas.

The conditions on the sun are similar to those in the experimental tube and it may be surmised that the noise from the sun is of the same character as the noise described here.

CARL-ERIK FRÖBERG, Department of Mechanics and Mathematical Physics, University of Lund

A determination of the nuclear interaction from proton-proton scattering

Experiments on protons have shown that the ^{1}S-phase alone is responsible for the scattering at low and medium energies (*i.e.* up to 7 MeV, but probably still higher). In this case one has a potential which is a function of the distance only, and the phase shift is a known function of the energy. Earlier a method had been outlined for the calculation of the potential from the phase shift, although the Coulomb-case was not taken into account. With small modifications, however, this procedure could also be used in this case. It will be necessary to evaluate integrals containing Coulomb wave-functions, this being facilitated by tables from Mathematical Tables Project in New York. — The first approximation will probably be bad but, anyway, it should be possible to get information concerning the range of the nuclear forces.

PER OLOF FRÖMAN, Department of Mechanics and Mathematical Physics, University of Uppsala

Interference of slow neutrons in small crystals

Neutrons cause interference phenomena in crystals, if their wave length is of the same order of magnitude as the lattice constant. Under the direction of Professor IVAR WALLER quantum mechanical calculations of these interferences have been performed, at which it was assumed that the crystals are so small that the absorption can be neglected.

A general formula for the total scattering cross section of a polycrystal was deduced. For simple lattices an earlier work by WEINSTOCK[1] gives a formula which essentially agrees with the one now presented. The new deduction is, however, much simpler.

Furthermore, formulas and methods, valid for cubic single crystals with only one type of atoms, were worked out to calculate the intensity of the diffuse scattering in the immediate neighbourhood of an interference point. The practical applications necessitate numerical computations, which are considerably more complicated than in the corresponding problem concerning x-rays.

GUNNAR HOLTE, Department of Mechanics and Mathematical Physics, University of Uppsala

On the space distribution of slowed-down neutrons

The distribution of slow neutrons from a point-source of fast neutrons in an infinite moderator has been studied. The purpose of the investigation is a calculation of the neutron density at distances where the elementary age theory gives quite wrong results. Assuming the mean free path λ to be a constant for all energies it has been possible to calculate analytic expressions for the neutron density for any distance R from the source. In the formula obtained, the principal factor can, for the values of R in consideration, be written:

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[1] Phys. Rev. *65*, 1 (1944).

$$\exp(-R\,f)$$

Here f is slowly variable and increases monotonically with R, and $\lim f = 1$ for $R \to \infty$ (provided that the unit of length $= \lambda$).

The slowing-down of neutrons in a medium with an energy-dependent mean free path has also been studied. In this case, too, the formulas for the neutron density have been extended beyond the range of validity of age theory.

Applications have been made to carbon and deuterium.

G. KÄLLÉN, Department of Mechanics and Mathematical Physics, University of Lund

Higher approximations of the vacuum-polarization in an external field

The convergence and gauge invariance of the integrals appearing in the higher approximations of vacuum polarization are discussed for the cases of spinor and scalar fields. Only the comparatively simple case of an external electromagnetic field is treated.

As a direct result of the charge-symmetry the vacuum expectation values of the current commutators vanish, if an odd number of current operators are commuted. Hence the terms proportional to e^{2n+1} are identically zero, and in this form the statement is true for both fermions and bosons. Of the remaining terms only the e^2 and e^4 approximations diverge, but the still higher terms are both convergent and gauge invariant. It further appears that, apart from a numerical factor, which is the same in both approximations (and equal to $-1/2$), the strongest divergences are the same for the scalar and spinor fields.

The e^2 approximation has previously been treated by JOST and RAYSKI, who have shown that the non-gauge invariant (and divergent) terms compensate each other, if one uses a suitable mixture of spinor and scalar fields. In this approximation, however, the logarithmically divergent charge-renormalization remains.

The conditions of JOST and RAYSKI are

$$\left.\begin{aligned} N &= 2n \\ \sum_{i=1}^{i=N} M_i^2 &= 2\sum_{i=1}^{i=n} m_i^2 \end{aligned}\right\} \qquad \begin{aligned} &(\mathrm{I}) \\ &(\mathrm{II}) \end{aligned}$$

where N and n are the number of scalar and spinor fields respectively, and M_i and m_i are the corresponding masses. In the e^4 approximation, the condition (I) alone is sufficient to secure a convergent and gauge invariant result.

A more detailed account of the calculations is in the press in the Helvetica Physica Acta.

HELMER BÄCKSTRÖM, Department of Photography, Royal Institute of Technology, Stockholm

The influence of static pressure on the sensitivity of photographic emulsions

For several years an investigation has been in progress in this laboratory concerning a pressure-effect on photographic material, discovered by F. E. POINDEXTER. This manifests itself in such a manner that, if a photographic layer is subjected to great pressure during exposure, a lower degree of blackening is obtained in the areas in question after developing. On the other hand, no diminution of the blackening is obtained if the pressure is applied before or after the exposure. No investigator in this field has yet attempted to explain this phenomenon. The author is of the opinion that the effect is caused by a decrease in electrolytic conductivity of the bromide crystals in the layer, when this layer is subjected to pressure. An investigation of the influence of pressure on the conductivity of crystalline bromide layers (not emulsions) showed the right sign for the influence of pressure, and from the change in resistance the photographic effect could be calculated, whereby the correct order of magnitude was obtained. The experimentally observed photographic pressure-effect was proved to consist of two parts, namely the pressure effect, caused by the change in the conductivity with pressure, and an optical effect, caused by optical contact between the pressed film and the glass plate against which it is pressed, and through which it is exposed. The latter effect increases with increasing pressure up to a definite maximum and therefore is easy to correct for. The author and his co-workers also have studied the influence of the pressure on the HERSCHEL effect, influences from the reciprocity law, etc.

INGA FISCHER, Department of Mechanics and Mathematical Physics, University of Stockholm

A molecular orbital treatment of some saturated and unsaturated ethers

In connection with experimental studies of diethyl ether and divinyl ether we have calculated the charge distributions and the bond orders of these molecules. Corresponding calculations have also been performed for dimethyl ether and ethylvinyl ether. We have found a clear difference between the suturated ethers and the unsaturated ones. The negative charge on the oxygen atom is less and the C–O bond order is higher in molecules with the configuration $O{-}CH{=}CH_2$ than in the corresponding saturated compounds. This result depends upon the interaction between the single 2p electron pair of the oxygen atom and the π-electrons of the double bond. The interaction causes a shortening of the C–O bond, computed to 0.02 Å (experimentally: 0.01 Å), and a decrease of the C–O bond moment, computed to 0.17 Debye (experimentally: 0.15 Debye). Detailed results will be published in Arkiv för fysik.

G. ANIANSSON, Department of Theoretical Chemistry, Royal Institute of Technology, Stockholm

Studies of surface adsorption in solutions with radioactive isotopes

A new method for studies of surface adsorption in solutions was described, based on the use of radioactive isotopes with short range radiations, such as alpha-emitters,

C^{14}, S^{35}, Ca^{45}, H^3 etc. An isotope of this kind is built into the compound whose surface adsorption is to be studied, and a suitable detector, such as a G.M. counter or scintillation counter, is placed immediately over the surface of the solution. The detector counts not only particles from the adsorbed surface layer but also some of those coming from the interior of the solution. The fraction of the total number of particles coming from the interior of the solution decreases with the range of these particles, and this fraction can be determined by making a similar measurement on the same isotope in a non-surface-active compound.

So far measurements have been made on $C_{18}H_{37}SO_4Na$, with built-in S^{35}, in water solutions to test GIBBS' equation for surface adsorption in solutions. The adsorption of $C_{18}H_{37}SO_4Na$ has also been measured using a mixture with $C_{12}H_{25}SO_4Na$, a solution whose surface tension varies in an anomalous way with the concentration.

LARS MELANDER, Nobel Institute for Physics, Stockholm

An application to organic chemistry of the difference in reaction rate between isotopes

In the case of the lightest elements, especially hydrogen, the reaction rates of isotopes may be materially different. In tracer experiments this fact may cause difficulties, but it is also possible to use the difference for investigations in reaction kinetics.

If a reaction, actual or hypothetical, is so thoroughly known that all energy levels of both the initial molecules and the "activated complex" are known, it is possible to calculate the absolute values of the two velocities according to the theory of absolute reaction rates. In most cases little is known about the activated complex, and then it is only possible to calculate an extreme value for the rate ratio. These things have been discussed by J. BIGELEISEN (*e.g.* Brookhaven Conference Report, Chemistry Conference 2, Dec. 1–3, 1948).

The common aromatic substitution reactions, which are of the electrophilic type, have been investigated by means of tritium (^3H). The ratio in which tritium and protium in equivalent positions are substituted has been measured. If the hydrogen-loss is rate-determining, a smaller velocity for the C–T bond than for the C–H bond is to be expected, mainly due to the difference in zero point energy. If, on the other hand, some addition is rate-determining, no velocity difference is to be expected.

Thus the nitration of benzene and toluene by means of a nitric-sulphuric acid mixture and that of naphthalene by means of nitric acid have been shown to proceed with the same velocity for C–T and C–H bonds, which means that the hydrogen-loss is rapid and not determining for the place of substitution. These observations are in accordance with results obtained in another way by C. K. INGOLD *et al.* and others.

Results hitherto obtained in the bromination of benzene indicate that the catalyst determines, which of the two alternatives is realized.

R. VESTERGAARD, Research Institute of National Defence, Stockholm

Noise and stability problems in linear amplifiers

The difficulties were described, which are met with in making linear amplifiers of high gain-band width product which are stable, and which are shielded against electrical noise caused by outside interference.

It was explained, how failure to meet these two requirements is connected with the existence of unwanted signal and feed-back channels, which may consist of one or more of the power-supply conductors, and the screening boxes.

Correct methods of filtering and screening are proposed to avoid noise caused by outside interference. Regarding stability, a number of possible feed-back channels which may cause oscillation or serious distortion are discussed, together with the proper ways of getting rid of such faults in practice. Finally, the importance of not placing moving elements or noisy components in, or close to, extremely sensitive amplifier stages, is mentioned.

TOR WIEDLING, Department of Physics, University of Stockholm

A coincidence circuit with short resolving time

Scintillation counters make it possible to use coincidence circuits with resolving times as short as 10^{-8}–10^{-9} seconds. Commercial photo-multiplier tubes have a current amplification of about 10^6. Thus, further amplification is necessary if coincidence circuits of conventional types are used. It is difficult to make conventional pulse amplifiers with high voltage amplification as rapid as is required and, for that reason, preliminary tests have been made with a coincidence circuit of cathode follower type operated with small pulses.

N. STRANDELL, Department of Electronics, Royal Institute of Technology, Stockholm

Photographic investigation of electron beams in a high vacuum

A photographic investigation has been made of trochoidal electron beams at a pressure of 10^{-5} mm Hg. A description of the apparatus was given and some of the results obtained were presented. The influence of different gases and pressures on the spread of the electron beam was described in detail.

T. WALLMARK, Department of Electronics, Royal Institute of Technology, Stockholm

Electron valve with space charge beam deflection

A new principle for the control of current in an electron valve is presented, especially suited for broad band amplification. The tube has a figure of merit $G_m/2\pi C$ not only larger than conventional pentodes but also larger than valves with secondary emission multiplication. In addition the tube has a high transconductance-to-current ratio, resulting in an equivalent noise resistance comparable to that of the best pentodes. A complete presentation is to be made at the IRE meeting in March 1950 in New York.

J. BJÖRKMAN, Department of Electronics, Royal Institute of Technology, Stockholm

The circular trochotron

During the development of the trochotron[1], a circular design with central cathode was built. This valve resembles a magnetron but has boxes with the "spades" and the "plates" of the trochotron. The mode of operation of the circular trochotron is the same as that of the original design.

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[1] Transactions of the Royal Institute of Technology, No. 22 (1948).

The geometrical arrangement of the electrode system is a compromise, as the electric field around the cathode has to be rather homogeneous and, at the same time, the openings to the boxes have to be sufficiently large.

The main advantage of the circular trochotron is the large current obtained at relatively low voltages, thus enabling high switching frequencies to be used.

L. Lindberg, Department of Electronics, Royal Institute of Technology, Stockholm

The binary trochotron

The binary trochotron is an electron tube especially suited to indicate and distribute coincidences between electric pulses. The tube might be used in electronic calculating machines for the addition of binary numbers.

Tryckt den 7 juni 1950

Uppsala 1950. Almqvist & Wiksells Boktryckeri AB